

## REMARKS

The errors noted by the Examiner in the Specification have been corrected. The remaining claims are 22-32, 46-72, 86-98, 114-116, 118, and 128. Claims 59-66, 70-71, 86-92, 116, 118, and 128 have been allowed.

1. Informalities. Claims 86 and 128 contained errors in the spacing of the subscripts, claim 22 required a space between "the" and "formula", and claims 29, 53, 67, and 93 required correction in the spelling of "organometallics." These errors have been corrected.

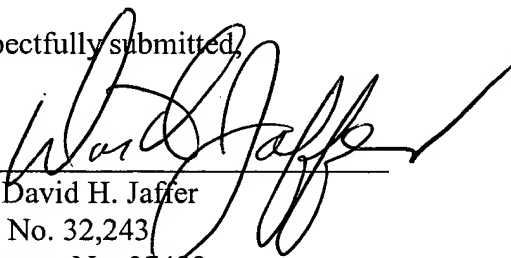
2. Section 112, second paragraph. Claim 46 has been amended to define "POSS fragment." Claims 29, 32, 53, 58, 67, 72, 93, and 98 have been amended to define the R and X groups. Claim 97 has been amended to address the antecedent basis issue. Applicants believe that in view of these amendments, claims 22-32, 46-58, 67-69, 72, 93-98, and 115 are now also allowable.

In addition, claim 114 has been re-written in independent form and is also believed to be allowable.

### CONCLUSION

Applicants have amended the claims to address the informalities and Section 112, second paragraph, objections. Applicants believe the remaining claims are now in condition for allowance. If any further questions should arise prior to a Notice of Allowance, the Examiner is invited to contact the attorney at the number set forth below.

Respectfully submitted,

  
By: David H. Jaffer  
Reg. No. 32,243  
Customer No. 27498

Date: January 2, 2003

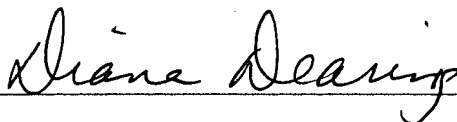
PILLSBURY WINTHROP LLP  
2550 Hanover Street  
Palo Alto, CA 94304-1115  
Tel: (650) 233-4510  
Fax: (650) 233-4545

Atty/Sec: DHJ/dld

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## **APPENDIX**

### **Versions with Markings to Show Changes Made**

#### **In the Specification**

##### **The specification is amended as follows:**

Please replace the paragraph beginning at page 2, line 1, with the following rewritten paragraph:

1       Prior art has reported that bases (e.g., NaOH, KOH, etc.) could be used to both catalyze  
2   the polymerization of POSS into lightly networked resins or to convert selected  
3   polysilsesquioxane resins into homoleptic polyhedral oligomeric silsesquioxane structures.  
4   Marsmann et al have more recently shown that a variety of bases can be used to redistribute  
5   smaller homoleptic POSS cages into larger sized homoleptic cages. (Marsmann, H.C. and  
6   Rikowski, E., Polyhedron, 1997, 16, 3357-3361). While there is precedent in the literature for  
7   treatment of silsesquioxanes and POSS systems with base, the previous art does not afford the  
8   selective manipulation of silicon-oxygen frameworks and the subsequent controlled production  
9   of POSS fragments, homoleptic POSS nanostructures, heteroleptic POSS nanostructures and  
10 functionalized heteroleptic POSS nanostructures. Furthermore, the prior art does not provide  
11 methods of producing POSS systems suitable for functionalization and subsequent  
12 polymerization or grafting reactions. This oversight in the prior art is reflective of the fact that  
13 the invention of POSS-based reagents, monomers and polymer technology has only recently been  
14 developed and consequently post-dates this prior art. Hence POSS compositions and processes  
15 relevant to the types of systems desired for POSS monomer/polymer technology were not  
16 envisioned in the prior art. Additionally the prior art does not demonstrate the action of bases on  
17 silane, silicate, or silsesquioxane feedstocks suitable for producing low-cost and high purity  
18 POSS systems.

Please replace the paragraph beginning at page 9, line 1, with the following rewritten paragraph:

1 For the above reaction scheme (Scheme 1) the polymeric silsesquioxane resin is  
 2 converted into either [Poss] POSS fragments or nanostructured POSS cage species depending on  
 3 the type of base and conditions employed. The conversion of polysilsesquioxanes  $[\text{RSiO}_{1.5}]_{\infty}$  to  
 4 POSS-species (homoleptic  $[(\text{RSiO}_{1.5})_n]_{\Sigma\#}$ , functionalized homoleptic  $[(\text{RSiO}_{1.5})_m(\text{RXSiO}_{1.0})_n]_{\Sigma\#}$ ,  
 5 heteroleptic  $[(\text{RSiO}_{1.5})_m(\text{RSiO}_{1.5})_n]_{\Sigma\#}$   $[(\text{RSiO}_{1.5})_m(\text{R}'\text{SiO}_{1.5})_n]_{\Sigma\#}$  and functionalized heteroleptic  
 6  $[(\text{RSiO}_{1.5})_m(\text{RXSiO}_{1.0})_n]_{\Sigma\#}$   $[(\text{RSiO}_{1.5})_m(\text{R}'\text{SiO}_{1.5})_n(\text{RXSiO}_{1.0})_p]_{\Sigma\#}$ ) or into POSS-fragments  
 7  $[(\text{RXSiO}_{1.5})_n]$  can be selectively controlled through manipulation of the process variables  
 8 discussed above. The process can be conducted using a polysilsesquioxane resin which may  
 9 contain only one type of R group to produce homoleptic  $[(\text{RSiO}_{1.5})_n]_{\Sigma\#}$  products. Alternatively  
 10 the process can be carried out using polysilsesquioxane resins containing more than one type of  
 11 R group or with mixtures of polysilsesquioxanes in which each contains different R groups to  
 12 afford heteroleptic  $[(\text{RSiO}_{1.5})_m(\text{RSiO}_{1.5})_n]_{\Sigma\#}$   $[(\text{RSiO}_{1.5})_m(\text{R}'\text{SiO}_{1.5})_n]_{\Sigma\#}$  products. For the above  
 13 reaction scheme (Scheme 1) in which mixtures of homoleptic POSS cages (i.e. R of one POSS  
 14 cage  $\neq$  R of the second POSS cage) are substituted for the polysilsesquioxane resin the process  
 15 effectively converts mixtures of homoleptically substituted POSS cages into heteroleptic POSS  
 16 cages (functionalized and nonfunctionalized) that contain statistical distributions of different R  
 17 groups per cage. In most cases the POSS fragments and various homo or heteroleptic  
 18 nanostructured POSS species can be separated from one another through crystallization, or  
 19 extractions by utilizing the differences in solubility between the reaction products and the starting  
 20 silsesquioxane.

Please replace the paragraph beginning at page 11, line 27, with the following rewritten paragraph:

1 Scheme 3 illustrates actual reactions that use the conditions described in Process II as  
 2 proof that the bases and conditions described in Process II are effective for the conversion of  
 3 functionalized POSS cages (i.e.  $[(\text{RSiO}_{1.5})_m(\text{RXSiO}_{1.0})_n]_{\Sigma\#}$  and  
 4  $[(\text{RSiO}_{1.5})_m(\text{R}'\text{SiO}_{1.5})_n(\text{RXSiO}_{1.0})_p]_{\Sigma\#}$ ) to desired POSS structures. It should also be noted that in  
 5 most cases this process results in an increase in the number of functionalities (X) on a POSS

6 nanostructure while at the same time maintaining the original number of silicon atoms contained  
7 within the starting nanostructural framework. This can be desirable for a variety of subsequent  
8 synthetic product manipulations and derivations.

### **In the Claims**

Cancel claims 8-21, 33-45, 73-85, 99-113, 117, 119-120, 122, and 134.

1 22. (Twice amended) A process of converting a polymeric silsesquioxane into a POSS  
2 fragment, comprising:

3 mixing an effective amount of a base with the polymeric silsesquioxane in a solvent to  
4 produce a basic reaction mixture, the base reacting with the polymeric silsesquioxane to produce  
5 the POSS fragment,

6 wherein the polymeric silsesquioxane has the formula  $[\text{RSiO}_{1.5}]_{\infty}$ , and the POSS fragment  
7 has the formula  $[(\text{RSiO}_{1.5})_m(\text{RXSiO}_{1.0})_n]$ , where R represents an organic substituent, X represents  
8 a functionality substituent,  $\infty$  represents the degree of polymerization and is a number greater  
9 than or equal to 1, and m and n represent the stoichiometry of [the formula] the formula.

1 29. (Once amended) The process of claim 28, wherein the base is selected from the group  
2 consisting of hydroxide  $[\text{OH}]^-$ , organic alkoxides  $[\text{RO}]^-$   $[\text{R}''\text{O}]^-$ , carboxylates  $[\text{RCOO}]^-$   
3  $[\text{R}''\text{COO}]^-$ , amides  $[\text{RNH}]^-$   $[\text{R}''\text{NH}]^-$ , carboxamides  $[\text{RC(O)NR}]^-$ ,  $[\text{R}''\text{C(O)NR}'' ]^-$ , carbanions  
4  $[\text{R}]^-$ ,  $[\text{R}'' ]^-$ , carbonate  $[\text{CO}_3]^{-2}$ , sulfate  $[\text{SO}_4]^{-2}$ , phosphate  $[\text{PO}_4]^{-3}$ , biphosphate  $[\text{HPO}_4]^{-2}$ ,  
5 [phosphorous] phosphorus ylides  $[\text{R}_4\text{P}]^-$   $[\text{R}''_4\text{P}]^-$ , nitrate  $[\text{NO}_3]^-$ , borate  $[\text{B(OH)}_4]^-$ , cyanate  
6  $[\text{OCN}]^-$ , fluoride  $[\text{F}]^-$ , hypochlorite  $[\text{OCl}]^-$ , silicate  $[\text{SiO}_4]^{-4}$ , stannate  $[\text{SnO}_4]^{-4}$ , basic metal oxides  
7 comprising  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ , and  $\text{ZnO}$ , amines  $[\text{R}_3\text{N}]$   $\text{R}''_3\text{N}$  and amine oxides  $[\text{R}_3\text{NO}]$   $\text{R}''_3\text{NO}$ , and  
8 [organometallics] organometallics comprising  $[\text{RLi}]$   $\text{R}''\text{Li}$ ,  $[\text{R}_2\text{Zn}]$   $\text{R}''_2\text{Zn}$ ,  $[\text{R}_2\text{Mg}]$   $\text{R}''_2\text{Mg}$ , and  
9  $[\text{RMgX}]$   $\text{R}''\text{MgX}'$ , where  $\text{R}''$  represents an organic substituent and multiple organic substituents  
10 need not be identical, and  $\text{X}'$  represents an inorganic substituent.

32. (Once amended) The process of claim 31, wherein the co-reagent is selected from the group consisting of common Grignard reagents  $[RMgX]$   $R''MgX$ , alkali halides, zinc compounds comprising  $ZnI_2$ ,  $ZnBr_2$ ,  $ZnCl_2$ , and  $ZnF_2$ , aluminum compounds comprising  $Al_2H_6$ ,  $LiAlH_4$ ,  $AlI_3$ ,  $AlBr_3$ ,  $AlCl_3$ , and  $AlF_3$ , and boron compounds comprising  $[RB(OH)_2]$   $R''B(OH)_2$ ,  $BI_3$ ,  $BBr_3$ ,  $BCl_3$ , and  $BF_3$ , where  $R''$  represents an organic substituent and  $X'$  represents an inorganic substituent.

46. (Twice amended) A process of converting a plurality of POSS fragments into a POSS compound, comprising:

mixing an effective amount of a base with the plurality of POSS fragments in a solvent to produce a basic reaction mixture, the base reacting with the POSS fragments to produce the POSS compound,

wherein the POSS fragments have the formula  $(RSiO_{1.5})_m(RXSiO_{1.0})_n$  and contain from 1 to 7 silicon atoms and no more than 3 rings, and the POSS compound is selected from the group consisting of homoleptic nanostructure compounds having the formula  $[(RSiO_{1.5})_n]_{\Sigma\#}$ , heteroleptic nanostructure compounds having the formula  $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$ , functionalized homoleptic nanostructure compounds having the formula  $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$ , functionalized heteroleptic nanostructure compounds having the formula  $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})_p]_{\Sigma\#}$ , and expanded POSS fragments having the formula  $(RSiO_{1.5})_m(RXSiO_{1.0})_n$ , where R and R' each represents an organic substituent, X represents a functionality substituent, m, n and p represent the stoichiometry of the formula,  $\Sigma$  indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

53. (Once amended) The process of claim 52, wherein the base is selected from the group consisting of hydroxide  $[OH]^-$ , organic alkoxides  $[RO]^-$   $[R''O]^-$ , carboxylates  $[RCOO]^-$   $[R''COO]^-$ , amides  $[RNH]^-$   $[R''NH]^-$ , carboxamides  $[RC(O)NR]^-$   $[R''C(O)NR]^-$ , carbanions  $[R]^-$   $[R']^-$ , carbonate  $[CO_3]^{2-}$ , sulfate  $[SO_4]^{2-}$ , phosphate  $[PO_4]^{3-}$ , biphosphate  $[HPO_4]^{2-}$ , [phosphorous] phosphorus ylides  $[R_4P]^-$   $[R''_4P]^-$ , nitrate  $[NO_3]^-$ , borate  $[B(OH)_4]^-$ , cyanate

6 [OCN]<sup>-</sup>, fluoride [F]<sup>-</sup>, hypochlorite [OCl]<sup>-</sup>, silicate [SiO<sub>4</sub>]<sup>-4</sup>, stannate [SnO<sub>4</sub>]<sup>-4</sup>, basic metal oxides  
7 comprising Al<sub>2</sub>O<sub>3</sub>, CaO, and ZnO, amines [R<sub>3</sub>N] R''<sub>3</sub>N and amine oxides [R<sub>3</sub>NO] R''<sub>3</sub>NO, and  
8 [organometallics] organometallics comprising [RLi] R''Li, [R<sub>2</sub>Zn] R''<sub>2</sub>Zn, [R<sub>2</sub>Mg] R''<sub>2</sub>Mg, and  
9 [RMgX] R''MgX', where R'' represents an organic substituent and multiple organic substituents  
10 need not be identical, and X' represents an inorganic substituent.

1 58. (Once amended) The process of claim 47, wherein the co-reagent is selected from the  
2 group consisting of common Grignard reagents [RMgX] R''MgX, alkali halides, zinc compounds  
3 comprising ZnI<sub>2</sub>, ZnBr<sub>2</sub>, ZnCl<sub>2</sub>, and ZnF<sub>2</sub>, aluminum compounds comprising Al<sub>2</sub>H<sub>6</sub>, LiAlH<sub>4</sub>,  
4 AlI<sub>3</sub>, AlBr<sub>3</sub>, AlCl<sub>3</sub>, and AlF<sub>3</sub>, and boron compounds comprising [RB(OH)<sub>2</sub>] R''B(OH)<sub>2</sub>, BI<sub>3</sub>,  
5 BBr<sub>3</sub>, BCl<sub>3</sub>, and BF<sub>3</sub>, where R'' represents an organic substituent and X' represents an inorganic  
6 substituent.

1 67. (Once amended) The process of claim 66, wherein the base is selected from the group  
2 consisting of hydroxide [OH]<sup>-</sup>, organic alkoxides [[RO]<sup>-</sup>] [R''O]<sup>-</sup>, carboxylates [[RCOO]<sup>-</sup>]  
3 [R''COO]<sup>-</sup>, amides [[RNH]<sup>-</sup>] [R''NH]<sup>-</sup>, carboxamides [[RC(O)NR]<sup>-</sup>,] [R''C(O)NR'']<sup>-</sup>, carbanions  
4 [[R]<sup>-</sup>] [R'']<sup>-</sup>, carbonate [CO<sub>3</sub>]<sup>-2</sup>, sulfate [SO<sub>4</sub>]<sup>-2</sup>, phosphate [PO<sub>4</sub>]<sup>-3</sup>, biphosphate [HPO<sub>4</sub>]<sup>-2</sup>,  
5 [phosphorous] phosphorus ylides [[R<sub>4</sub>P]<sup>-</sup>] [R''<sub>4</sub>P]<sup>-</sup>, nitrate [NO<sub>3</sub>]<sup>-</sup>, borate [B(OH)<sub>4</sub>]<sup>-</sup>, cyanate  
6 [OCN]<sup>-</sup>, fluoride [F]<sup>-</sup>, hypochlorite [OCl]<sup>-</sup>, silicate [SiO<sub>4</sub>]<sup>-4</sup>, stannate [SnO<sub>4</sub>]<sup>-4</sup>, basic metal oxides  
7 comprising Al<sub>2</sub>O<sub>3</sub>, CaO, and ZnO, amines [R<sub>3</sub>N] R''<sub>3</sub>N and amine oxides [R<sub>3</sub>NO] R''<sub>3</sub>NO, and  
8 [organometallics] organometallics comprising [RLi] R''Li, [R<sub>2</sub>Zn] R''<sub>2</sub>Zn, [R<sub>2</sub>Mg] R''<sub>2</sub>Mg, and  
9 [RMgX] R''MgX', where R'' represents an organic substituent and multiple organic substituents  
10 need not be identical, and X' represents an inorganic substituent.

1 72. (Once amended) The process of claim 71, wherein the co-reagent is selected from the  
2 group consisting of common Grignard reagents [RMgX] R''MgX, alkali halides, zinc compounds  
3 comprising ZnI<sub>2</sub>, ZnBr<sub>2</sub>, ZnCl<sub>2</sub>, and ZnF<sub>2</sub>, aluminum compounds comprising Al<sub>2</sub>H<sub>6</sub>, LiAlH<sub>4</sub>,  
4 AlI<sub>3</sub>, AlBr<sub>3</sub>, AlCl<sub>3</sub>, and AlF<sub>3</sub>, and boron compounds comprising [RB(OH)<sub>2</sub>] R''B(OH)<sub>2</sub>, BI<sub>3</sub>,

5 BBr<sub>3</sub>, BCl<sub>3</sub>, and BF<sub>3</sub>, where R'' represents an organic substituent and X' represents an inorganic  
6 substituent.

1 86. (Twice amended - - **Note: Amendment corrects spacing of the subscripts in formulas**)

2 A process of converting an unfunctionalized POSS nanostructure compound into a functionalized  
3 POSS nanostructure compound, comprising:

4 mixing an effective amount of a base with the unfunctionalized POSS nanostructure  
5 compound in a solvent to produce a basic reaction mixture, the base reacting with the  
6 unfunctionalized POSS nanostructure compound to produce the functionalized POSS  
7 nanostructure compound,

8 wherein the unfunctionalized POSS nanostructure compound is selected from the group  
9 consisting of homoleptic nanostructure compounds having the formula [(RSiO<sub>1.5</sub>)<sub>n</sub>]<sub>Σ#</sub> and  
10 heteroleptic nanostructure compounds having the formula [(RSiO<sub>1.5</sub>)<sub>m</sub>(R'SiO<sub>1.5</sub>)<sub>n</sub>]<sub>Σ#</sub>, and the  
11 functionalized POSS nanostructure compound is selected from the group consisting of  
12 functionalized homoleptic nanostructure compounds having the formula  
13 [(RSiO<sub>1.5</sub>)<sub>m</sub>(RXSiO<sub>1.0</sub>)<sub>n</sub>]<sub>Σ#</sub> and functionalized heteroleptic nanostructure compounds having the  
14 formula [(RSiO<sub>1.5</sub>)<sub>m</sub>(R'SiO<sub>1.5</sub>)<sub>n</sub>(RXSiO<sub>1.0</sub>)<sub>p</sub>]<sub>Σ#</sub>, where R and R' each represents an organic  
15 substituent, X represents a functionality substituent, m, n and p represent the stoichiometry of the  
16 formula, Σ indicates nanostructure, and # represents the number of silicon atoms contained  
17 within the nanostructure.

1 93. (Once amended) The process of claim 92, wherein the base is selected from the group  
2 consisting of hydroxide [OH]<sup>-</sup>, organic alkoxides [[RO]<sup>-</sup>] [R''O]<sup>-</sup>, carboxylates [[RCOO]<sup>-</sup>]  
3 [R''COO]<sup>-</sup>, amides [[RNH]<sup>-</sup>] [R''NH]<sup>-</sup>, carboxamides [[RC(O)NR]<sup>-</sup>,] [R''C(O)NR'']<sup>-</sup>, carbanions  
4 [[R]<sup>-</sup>], [R'']<sup>-</sup>, carbonate [CO<sub>3</sub>]<sup>-2</sup>, sulfate [SO<sub>4</sub>]<sup>-2</sup>, phosphate [PO<sub>4</sub>]<sup>-3</sup>, biphosphate [HPO<sub>4</sub>]<sup>-2</sup>,  
5 [phosphorous] phosphorus ylides [[R<sub>4</sub>P]<sup>-</sup>] [R''<sub>4</sub>P]<sup>-</sup>, nitrate [NO<sub>3</sub>]<sup>-</sup>, borate [B(OH)<sub>4</sub>]<sup>-</sup>, cyanate  
6 [OCN]<sup>-</sup>, fluoride [F]<sup>-</sup>, hypochlorite [OCl]<sup>-</sup>, silicate [SiO<sub>4</sub>]<sup>-4</sup>, stannate [SnO<sub>4</sub>]<sup>-4</sup>, basic metal oxides  
7 comprising Al<sub>2</sub>O<sub>3</sub>, CaO, and ZnO, amines [R<sub>3</sub>N] R''<sub>3</sub>N and amine oxides [R<sub>3</sub>NO] R''<sub>3</sub>NO, and  
8 [organometallics] organometallics comprising [RLi] R''Li, [R<sub>2</sub>Zn] R''<sub>2</sub>Zn, [R<sub>2</sub>Mg] R''<sub>2</sub>Mg, and



9 [RMgX]  $R''MgX'$ , where  $R''$  represents an organic substituent and multiple organic substituents  
10 need not be identical, and  $X'$  represents an inorganic substituent.

1 97. (Twice amended) The process of claim 86, further comprising mixing a co-reagent with  
2 the base and the [polymeric silsesquioxane] unfunctionalized POSS nanostructure compound in  
3 the solvent.

1 98. (Once amended) The process of claim 97, wherein the co-reagent is selected from the  
2 group consisting of common Grignard reagents [RMgX]  $R''MgX$ , alkali halides, zinc compounds  
3 comprising  $ZnI_2$ ,  $ZnBr_2$ ,  $ZnCl_2$ , and  $ZnF_2$ , aluminum compounds comprising  $Al_2H_6$ ,  $LiAlH_4$ ,  
4  $AlI_3$ ,  $AlBr_3$ ,  $AlCl_3$ , and  $AlF_3$ , and boron compounds comprising  $[RB(OH)_2]$   $R''B(OH)_2$ ,  $BI_3$ ,  
5  $BBr_3$ ,  $BCl_3$ , and  $BF_3$ , where  $R''$  represents an organic substituent and  $X'$  represents an inorganic  
6 substituent.

1 114. (Once amended) [The process of claim 8, wherein] A process of converting a polymeric  
2 silsesquioxane into a POSS nanostructure compound, comprising:  
3 mixing an effective amount of a base with the polymeric silsesquioxane in a solvent to  
4 produce a basic reaction mixture, the base reacting with the polymeric silsesquioxane to produce  
5 the POSS nanostructure compound,  
6 wherein the polymeric silsesquioxane has the formula  $[RSiO_{1.5}]_\infty$ , and the POSS  
7 nanostructure compound is  $[(RSiO_{1.5})_4(RXS_iO_{1.0})_3]_{\Sigma 7}$ , where  $R$  represents an organic substituent,  
8  $X$  represents a functionality substituent,  $\infty$  represents the degree of polymerization and is a  
9 number greater than or equal to 1,  $m$ ,  $n$  and  $p$  represent the stoichiometry of the formula,  $\Sigma$   
10 indicates nanostructure, and  $\#$  represents the number of silicon atoms contained within the  
11 nanostructure.

1 128. (Twice amended - - **Note: Amendment corrects spacing of the subscripts in formulas**)  
2 A compound having the formula  $[(XSiO_{1.5})_n]_{\Sigma \#}$ , where  $X$  represents a functionality substituent,  $n$   
3 represents the stoichiometry of the formula,  $\Sigma$  indicates nanostructure, and  $\#$  represents the  
4 number of silicon atoms contained within the nanostructure.